

IBM Technical Papers Published in Other Journals

Calculation of Heat Flow in a Medium the Conductivity of Which Varies With Temperature, Richard L. Garwin, *Review of Scientific Instruments*, **27**, No. 10, 826 (October 1956).

It is shown that the heat flow in a single homogeneous medium of thermal conductivity $\sigma(T)$, between boundaries at temperatures T_2 and T_1 is the same as that for the same geometry in a medium of unit thermal conductivity and boundary "thermal potentials" $\Sigma(T_2)$ and $\Sigma(T_1)$, where $\Sigma(T) = \int_0^T \sigma(T') dT'$. Some applications are given, as well as a short table of $\Sigma(T)$ for common cryogenic temperatures and materials.

A Data Transmission Machine, C. R. Doty and L. A. Tate, *Communications and Electronics*, 600-603 (November 1956).

This paper describes the IBM Data Transceiver, developed to communicate accounting, statistical, engineering and scientific data over a wide range of distances. The problems of transmitting data, as opposed to transmitting message traffic, are discussed. The Data Transceiver reads and transmits information from punched cards and records the information by punching cards at the receiving location. Transmission may be over telephone or telegraph circuits, using wire lines, radiotelegraph, or microwave facilities. Means for detecting and correcting transmission errors (character mutilation) are included. The Data Transceiver consists of two units: one includes the card reading and punching mechanism, for sending or receiving; the other contains the electronic commutator and circuitry for transmitting and receiving signals.

A Design for the Logic of the Recognition of Printed Characters by Simulation on the IBM 650 MDDPM, E. C. Greanias, C. J. Hoppel, M. Kloomok, J. S. Osborne, *Proceedings of the IEE*, **103**, Part B, Supplement No. 3 (1956).

A logic for the recognition of printed characters employing a proportional-parts method has been tested extensively by simulation; the method relates the identity of a character to the relative size and position of character elements detected by optical scanning along closely spaced vertical lines, the video information from each scan being coded to designate the number, size and position of inked areas detected by the scanner. The time sequence of this coded information is tested by logical circuits against prescribed sequences for character recognition. A set of coding definitions, a prescribed sequence for the recognition of a given character, and the methods of simulative testing of the recognition logic on a magnetic-drum data-processing machine are discussed.

The Design of the IBM 705 Memory System, R. E. Merwin, *Proceedings of the IRE PGEC*, 219-223 (December 1956).

The IBM 705 is a large-scale data processing machine designed for commercial applications. It consists of a central processing unit which performs arithmetic and logical operations on business data at very high speed, auxiliary data storage in the form of magnetic tapes and drums, and input-output media which include punched card equipment and line printers. Within the central processing unit there is a requirement for a large rapid-access memory which can be addressed at random, plus several smaller memories called storage units. This paper describes the logical system of these memories, in which the magnetic core is used as the storage element.

Discontinuous Field Induced Transitions in Barium Titanate Above the Curie Point, Maurice Drougard, *Journal of Applied Physics*, **27**, No. 12, 1559-1560 (December 1956).

It has been known for some time that barium titanate exhibits double hysteresis loops in the range of a few degrees above the Curie point. Double hysteresis loops observed up to now are characterized by very slow transitions between the two states of polarization involved. It is shown that proper preparation of the samples leads to extremely fast and discontinuous transitions.

High Speed Coincident-Flux Magnetic Storage Principles, L. P. Hunter and E. W. Bauer, *Journal of Applied Physics*, **27**, No. 11, 1257-1261 (November 1956).

In conventional coincident-current magnetic storage systems, a specific storage element is selected by simultaneous application, to two or more intersecting wires, of currents of such magnitudes that their sum will produce a magnetic field sufficient to switch the element and such that the presence of any one of the selecting currents alone will not cause the element to switch. In the system described here, a coincident summation of magnetic flux causes the element to switch, and the magnitudes of the currents inducing the flux are not critical. This allows the switching time to be freed of the current-selection-ratio limitation typical of the coincident-current selection systems. In the coincident-flux system, one may use selecting flux densities representing fields very much greater than the coercive field, giving very fast switching times.

Hyperfine Structure of Metastable Deuterium, H. Reich, J. Heberle,* and P. Kusch,* *Physical Review*, **104**, 1585 (December 15, 1956).

The hyperfine separation $\Delta F(2S;D)$ of the metastable $2^2S_{1/2}$ state of the deuterium atom has been measured by an atomic-

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beam magnetic-resonance method that has been described previously. It was found that $\Delta\nu(2S;D) = 40924.439 \pm 0.020$ kc/sec. From this result and the ground-state separation $\Delta\nu(1S;D)$ we obtain $R(D) \equiv \Delta\nu(2S;D)/\Delta\nu(1S;D) = \frac{1}{3}(1.0000342 \pm 0.0000006)$. Comparison of this value with the corresponding quantity for hydrogen, $R(H) = \frac{1}{3}(1.0000346 \pm 0.0000003)$, confirms within experimental error the theoretical prediction that $R(D) = R(H)$.

Magnetic Data Recording Theory: Head Design, A. S. Hoagland, *Communication and Electronics*, 506-512 (November 1956).

An analysis of the process of magnetic recording of digital data is presented from which qualitative design concepts are developed and their usefulness demonstrated, both in the evaluation of magnetic head structures and in their design for high-density storage. The insight derived from the theory and its relative simplicity in application is illustrated through its successful employment in guiding head-design development in connection with the IBM Type 350 magnetic-disk file.

Numerical Integration of Differential Equations on the 704 EDPM, H. H. Anderson and J. R. Johnson, *Communication and Electronics*, No. 27, 569-574 (November 1956).

To provide a convenient means for solving complex and nonlinear ordinary differential equations, a system has been devised which causes a 704 EDPM to behave like an analogue differential analyzer. Use of this system involves the interconnection of appropriate subroutines in a manner analogous to the interconnection of operational amplifiers in an analogue machine. The subroutines are designed so that the user may compile the required connections automatically, without much knowledge of digital computer coding. Solving differential equations by this method takes no more setup time than that required by analogue machines and in many cases may be a good deal faster. Integration is done by using Milne's formulas. The system automatically adjusts the integration interval to take advantage of portions of the solution which can be computed with large intervals at no sacrifice of accuracy. Nonlinear functions may be expressed by a table of values in storage.

Synchro and Resolver Performance Definitions, L. A. Knox, *IRE Transactions on Component Parts* (December 1956).

A description is given of "synchro" devices used for the transmission of angular information in the form of 3-wire line voltages, and of "resolvers" used for solving trigonometric equations. A consistent set of fundamental synchro and resolver definitions is presented, along with some application notes. The definitions are divided into three sections, which include: precision resolver definitions, synchro control transmitter definitions and synchro performance definitions.

Each subject is treated regarding characteristics, error considerations and schematic diagram discussions.

Theory of Transport Effects in Semiconductors: Thermoelectricity, P. J. Price, *Physical Review*, 104, No. 5, 1223 (December 1, 1956).

The phenomenological theory of the thermoelectric effects in a cubic or isotropic electronic conductor is developed. It is shown that, as a consequence of the appropriate Onsager relation, the "gauge" adopted here for the thermoelectric coefficients of a single substance is such that the second Kelvin relation takes a specially simple form for a single substance. The general formulas obtained are applied to the theory of thermoelectricity in a two-band semiconductor, and the formulas for the thermoelectric power stated in a previous paper are derived. The Onsager principle leads to a general relation between two phenomenological transport parameters for a single carrier band, one (γ) measuring the ratio of thermodiffusion coefficient to drift mobility, the other (δ) specifying the thermal energy transported with the current due to an electric field. The modification of these results needed to take account of the variation of band-edge energies with temperature is discussed. The evaluation of thermoelectric data for mixed semiconductors, on the basis of the present results, is discussed and some experimental data for germanium analyzed. The effects of a strong magnetic field and of strain on the thermoelectric power are treated. It is pointed out that shear strain should change the activation energy for an impurity binding a carrier in a "many valley" band by decoupling the orbitals associated with different valleys and interacting through the chemical shift effect, and that this change should, among other consequences, appreciably change the thermoelectric power at very low temperatures. Exact formulas for this decoupling effect are obtained for donors in germanium.

The Use of Computing Machines in the Statistical Evaluation of Electrical Components, W. E. Andrus, Jr., *Communication and Electronics*, No. 27, 501-505 (November 1956).

Illustrative examples are given of the use of mathematical statistics and computing machines in research and development laboratories. These examples involve evaluation of electrical and electronic components and include considerations of operating characteristics of relays and life testing of rectifiers. Simple machine solutions for statistical evaluation are shown to be obtainable by tailored programs and programming techniques.

Pyrrolealdehyde, R. M. Silverstein,* E. E. Ryskiewicz, and C. Willard,* *Organic Syntheses*, 36, 74-77 (1956)

This paper presents the synthesis of 2-Pyrrolealdehyde, a key intermediate in the preparation of various pyrrole derivatives (work at Stanford Research Institute).

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